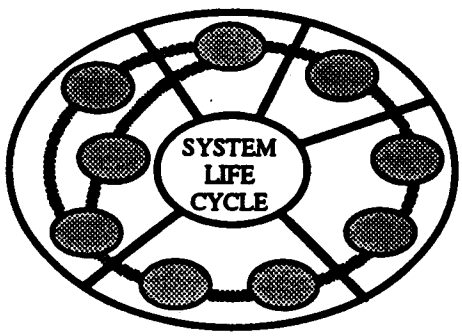
OFFICE OF SOLID WASTE AND EMERGENCY RESPONSE (OSWER)



SYSTEM LIFE CYCLE MANAGEMENT GUIDANCE

Part 3: Practice Paper

Configuration Management

January, 1989

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EXHIBITS

1. PRACTICE PAPER PURPOSE

This practice paper constitutes a section of Part 3 of the Office of Solid Waste and Emergency Response (OSWER) System Life Cycle Management Guidance. It describes OSWER's practice of configuration management, tailoring industry proven configuration management methods and techniques to the OSWER environment.

Configuration Management is a function which serves to systematically identify the characteristics of a system (referred to as "configuration items"), and formally control any changes or additions to those items. Examples of configuration items include specific functional and data requirements, the system design, and documentation such as the User Manual. Configuration Management helps maintain the integrity of the system throughout its life cycle, and facilitates communication about the system among system project team members, users, and other supporting organizations.

This practice paper provides the following guidance regarding the implementation of configuration management:

- Describes specific activities associated with configuration management;
- Describes project organization structures to accomplish configuration management; and
- Describes the documentation of project-specific configuration management activities in a Configuration Management Plan.

Ensuring the integrity of the system may be particularly challenging for a large and/or complex system. A rigorous and disciplined configuration management function will maintain system integrity for these systems, and all other systems as well, in the following ways:

- Helps ensure clear identification and documentation of functional and data requirements;
- Helps ensure that all approved requirements are traceable through the system design;
- Provides a means to unambiguously identify and reference the specific components of the system design and the actual system (e.g., subsystems, data bases, documentation);
- Helps ensure that an adequate review of requested changes to the system, and approval by an authorized organization and individual, takes place before the system is changed;

- Helps ensure effective control over changes to the software and release of changes to users;

- Provides a means to clearly identify the status of the system, and of individual system components, at any time throughout the life cycle;

- Helps ensure the consistency of products, such as the agreement of documentation with the applications software and other components of the system;

- Facilitates effective communication among system project team members, users, and other supporting organizations about the characteristics of the system and its status throughout the system life cycle; and

- Provides a means to reconstruct the evolution of the system, and rationale for significant decisions, through the prior phases and stages of the system life cycle.

This practice paper is not intended to provide detailed configuration management procedures. Rather, it describes the activities, organizational framework, and types of procedures that should be adopted by each system project for effective configuration management. The details of the procedures for a given project should be developed on a case by case basis to reflect the program needs, technical environment, and involved organizations for each project.

2. OVERVIEW OF CONFIGURATION MANAGEMENT ACTIVITIES AND PRACTICES

2.1. Configuration Management Overview

Configuration management encompasses six sets of related activities:

- Configuration Item Identification which identifies the characteristics of the system to be controlled by delineating specific configuration items;

- Baseline Management, which establishes repositories (or libraries) that contain the documentation of these items;

- Change Control, which ensures that only advantageous changes are made to the system as it exists in the controlled baselines;

- o Software Control, which preserves the integrity of the software while changes are being made;

- o Configuration Accounting, which monitors the status of the configuration items, and requested changes to the system in terms of their impact on specific configuration items; and

- o Configuration Audits, which confirm the proper working of the configuration management function and help ensure that system documentation is complete and current.

These activities are performed throughout the system life cycle, starting with the Initiation phase and continuing through the end of system operations in the Archive stage. Exhibit 2-1 provides an overview of configuration management throughout the system life cycle.

2.2. Configuration Item Identification

Configuration item identification serves to clearly delineate the significant characteristics of the system, providing a common language, or referencing scheme, for describing the system. It is the delineation of specific configuration items that will enable all individuals involved in the evolution of the system to communicate effectively, using the common language. Examples of such characteristics include specific functional and data requirements, specific characteristics of the system design (e.g., subsystems, files, (etc.) and system documentation. Each characteristic, or set of related characteristics, is referred to as a configuration item. The delineation of individual configuration items can be viewed as creating the 'labels' for the characteristics described in the conventional documentation of the system. For example, the design for a system's application programs that produce reports for use by regional offices may be delineated collectively as a single configuration item called 'Regional Report Programs'.

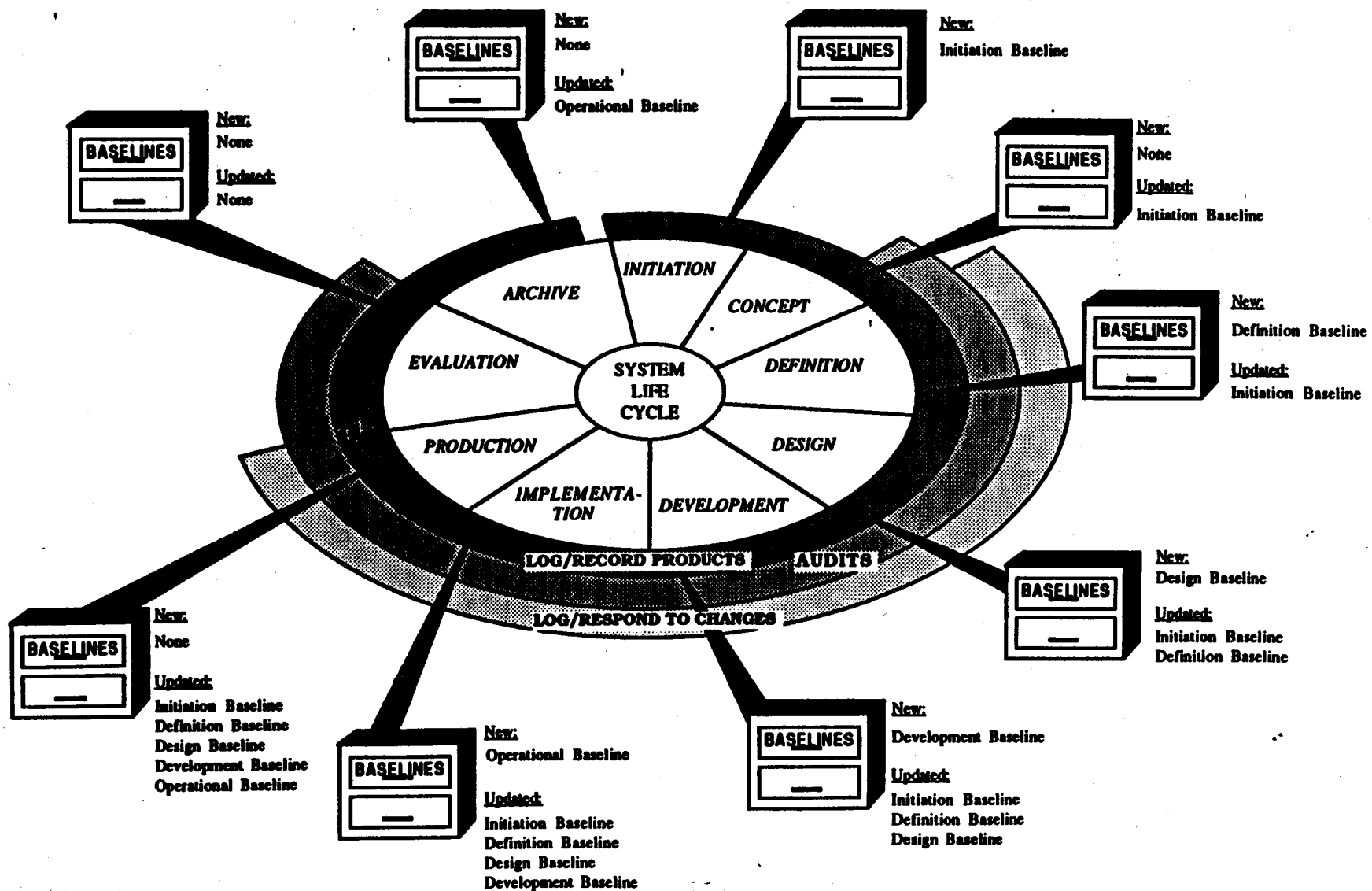
When conducting configuration item identification, be sure to note the following practices:

- o Configuration items delineate different types of system characteristics, and reflect the current phase and stage of the life cycle.

  - -- Individual functional and data requirements, or sets of related requirements, are delineated in the Definition stage;

  - -- Major attributes of the system design, are delineated in the Design stage, such as:

EXHIBIT 2-1: CONFIGURATION MANAGEMENT THROUGH THE SYSTEM LIFE CYCLE



- Hardware and technical environment(s)
- Logical data base structures
- Physical data base structures
- Applications software
- Utility software

-- The application software (i.e., programs), such as input and update processing, reporting, and system administration processes are delineated in the Design stage.

-- Specific system documentation, such as User Manual, Maintenance Manual, and Operations Manual are delineated in the Development stage.

o Configuration items are delineated and recorded in the normal documentation of the system life cycle. An index of configuration items should be included in each documentation product.

-- The index identifies specific configuration items.

-- The index also identifies specific relationships between configuration items in the same product (e.g., between different parts of the system design), and also relationships with previously defined items (e.g., between design configuration items and requirements configuration items).

-- The index helps confirm the traceability of the system throughout the life cycle, and is a vital tool to accomplish system audits.

2.3. System Baseline Management

System baselines are collections of life cycle products, including hardware and software, as well as the documentation of the system. An easy way to understand what a baseline is is to view it as a controlled library collection. Creating and managing baselines does not require the development of significant additional system documentation. System baselines are established throughout the life cycle to establish a clear basis for monitoring the status and progress of the system, and to facilitate communication (particularly for large system projects).

Five baselines are developed, and maintained, throughout the life cycle:

o Initiation Baseline - Contains documentation of the information management problem,

- Definition Baseline - Contains documentation of the functional and data requirements,

- Design Baseline - Contains documentation of all attributes of the system design,

- Development Baseline - Contains the automated and hardcopy products of development (including documentation), and of system changes, prior to installation in the user environment, and

- Operational Baseline - contains the automated and hardcopy products for the currently installed system.

Each baseline contains different life cycle products, and provides a different perspective of the system. Exhibit 2-2 illustrates the content of each baseline. Important characteristics of baselines and their development include the following:

- Baselines contain approved products only. Project teams should use other libraries to monitor the status of and control products that are under development and not yet approved.

- Baselines contain the product as first approved, and subsequent approved changes. For documentation, changes may be added to the baseline in the form of an entirely new document, a replacement document, or as an addenda or replacement pages.

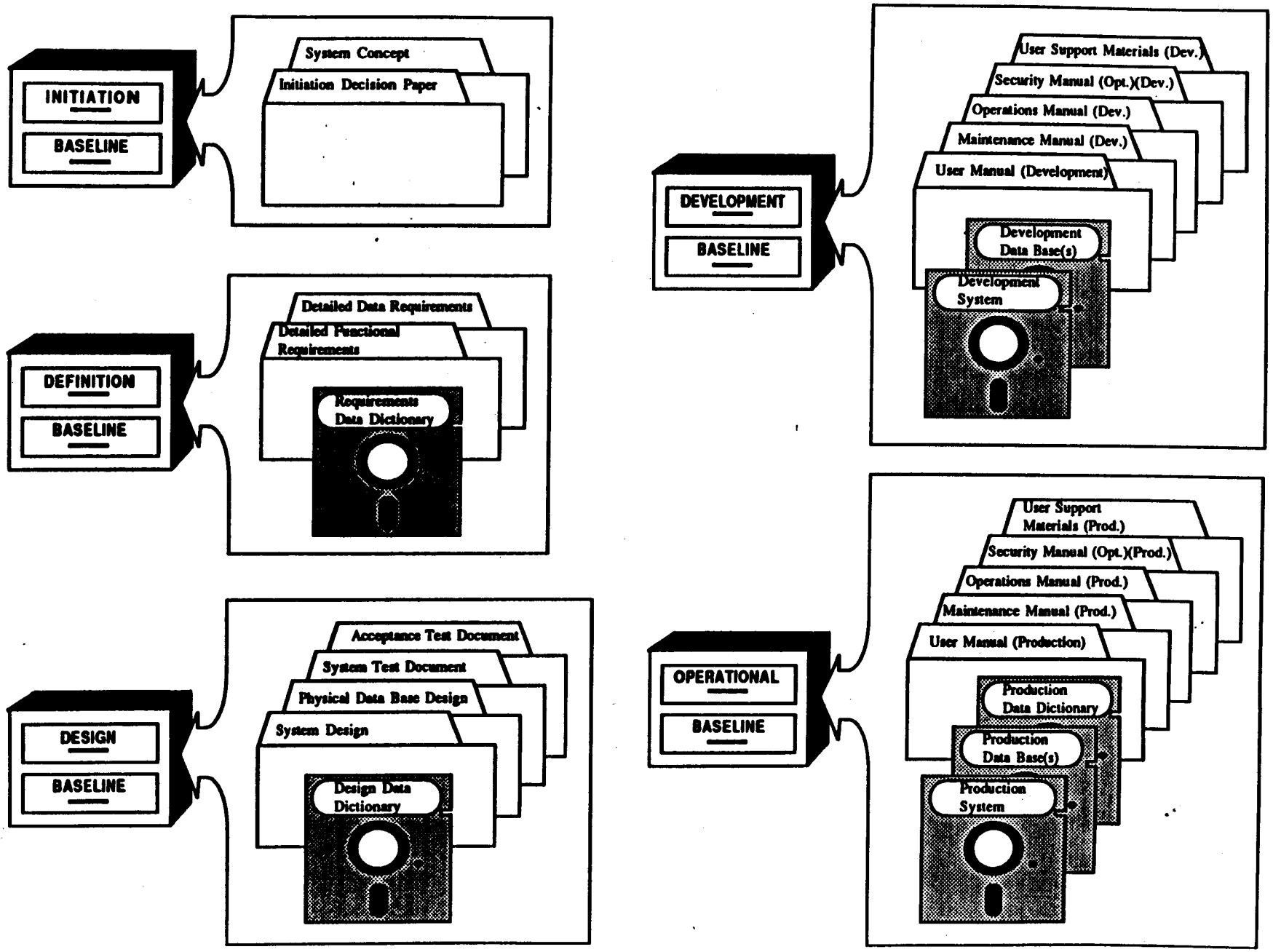
- All baselines are maintained throughout the life of the system, not just the operational system. If the information management problem changes, or the approved requirements for the system or system design change, it is essential to keep all of the established baselines current in order to have available complete, accurate, documented information about all aspects of the system.

2.4. Change Control

Change control is a formal process for determining what changes are to be made to the system. Change control requires the documentation of specific requests for modifications, and a review of the requested modifications, and consideration of their impact on the system, before they are made. The term 'modifications' refers both to changes and to minor enhancements. Change control determines which requested modifications will be made and which will not be made.

Change control applies to modifications requested after the system concept is approved and before the system is implemented, as well as to requests to modify fully operational system. For a system under development, the process for approving changes

EXHIBIT 2-2: CONTENT OF SYSTEM BASELINES



may be integrated with the formal approval process that takes place at the end of each stage of the life cycle. However, since these formal approvals are occur at the end of the stage, it is better to establish a separate change control process, and include a summary of changes approved using this process as part of the System Decision Paper submitted for formal approval at the end of each stage.

Other important aspects of change control include the following:

- Change control provides an examination of requested changes to the system before the system is changed. This examination is referred to as a 'Change Request Impact Analysis'. This analysis considers all pertinent characteristics of the change:
  - -- Functional and/or data requirement,
  - -- Reason for the change (e.g., new regulation or program policy),
  - -- Benefits of making the change,
  - -- Impact of not making the change on OSWER program operations, and the associated organizations,
  - -- Specific system configuration items impacted by the change, and extent of impact,
  - -- Impact of the change on related systems and data bases,
  - -- Cost of accomplishing the change, (including both onetime costs, and recurring costs [operations and maintenance], and expected source of funds),
  - -- Impact of the change on user organization procedures and/or staffing requirements,
  - -- Timeframe for accomplishing the change,
  - -- Potential risks in making the change (i.e., is successful change a certainty?),
  - -- Disposition of prior requests for the same change or a comparable change.
- Requested changes for a system under development may apply to system characteristics that have not yet been approved and recorded in a baseline. The Project Manager should design a process for determining how to handle these requests, and document the process in the

Configuration Management Plan. The process may be the same one used to decide how to handle requested changes to previously approved configuration items.

2.5. Software Control

Software control is a set of procedures to ensure that the integrity of the system is preserved when approved changes are being made to the system, or in the event of a disaster and restoration of the system is needed. Software control procedures are particularly important during the Production stage of the life cycle. Software control ensures that changes to the computer programs are developed and tested using a copy of the programs and a test data base, and do not adversely affect system users. However, software control is also important during the Development and Implementation stages to control changes during the initial building and installation of the system. For each system, the software control procedure should cover the following points:

- Describes how the development and operational environments of the system will be segregated.
- Describes the procedures to be used to install new versions of the software in the production environment, including procedures to ensure that a system installed at multiple locations (e.g., regional logical mainframes, multiple personal computers, etc.) is properly integrated and distributed data bases are effectively synchronized.

Other topics may be included as appropriate to the system.

2.6. Configuration Accounting

Configuration Accounting is an administrative procedure for maintaining system baselines and monitoring the status of the system throughout the life cycle. Important elements of this procedure include:

- Logging and storing each life cycle product in the appropriate baselines upon the approval of the product.
- Recording all requested changes, maintaining a log of change requests, and also recording the disposition of each request (e.g., approved, held pending further analysis, disapproved).
- Monitoring the status of approved changes, and recording completed changes in the appropriate baseline. Specific tracking points are determined for each system and/or change as appropriate.

- Providing the records used to accomplish configuration audits.

The Configuration Accounting procedure may also include activities for producing copies of approved and baselined system documentation for use by project team members (including contractors) throughout the life cycle.

2.7. Configuration Audits

Configuration Audits are examinations of the products and related documents submitted for inclusion in a baseline to assure that they are complete, clearly presented, and internally consistent. This examination is oriented to adherence to guidance and standards. These audits support formal reviews and evaluations of the system by ensuring that required products and documents are complete (e.g., meet identified standards), and provide effective traceability to related products. (Of particular note, audits do not evaluate qualitatively the programmatic and/or technical content of the product. That is done by formal reviews and other quality assurance activities.) Audits help ensure that the resources used to conduct reviews and evaluations are not applied to products that are not yet ready for the review.

Audits also help confirm the proper working of the configuration management function -- they help ensure that configuration accounting records are complete and current. As illustrated in Exhibit 2-1, audits are conducted throughout the life cycle.

In general, one audit is conducted in each of the following stages:

- Concept
- Definition
- Design
- Development
- Implementation

For the Production stage, audits are conducted periodically, usually annually or every other year, during the Production stage. However, more frequent audits may be conducted in any stage to ensure that deficiencies found by a recent audit have been corrected.

3. CONFIGURATION MANAGEMENT ORGANIZATION

Implementation of effective configuration management requires the formal designation of configuration management responsibilities for each system project.

3.1. Configuration Manager

Each system project will have a single Configuration Manager. The Configuration Manager establishes and maintains the configuration management records for the system. This individual should be designated during the Concept phase, and should report directly to the Project Manager. For a small system, the Project Manager may serve as the Configuration Manager. Specific duties of the Configuration Manager should include:

- Maintaining a complete file and log of all change requests, including requests to modify system characteristics that are not yet approved and baselined, as well as requests to modify approved configuration items.

- Recording the disposition of all change requests, including approval/disapproval, and completion and implementation of the change.

- Preparing periodic reports of configuration status, as needed,

- Providing physical control over baselined documentation (e.g., retaining at least one official copy of the documentation), and

- Providing assistance and support to the performance of configuration audits.

The Configuration Manager is accountable for the completeness and integrity of the configuration management records, and should be an EPA employee. However, the Configuration Manager may obtain staff support using other members of the project team, including contractor support, as appropriate.

The Configuration Manager usually does not have specific decision making authority.

3.2. Change Control Board

Each system project will establish a Change Control Board. Change Control Boards examine requested changes to the system, direct the change request impact analysis (an analysis conducted by the project team) and, based on the results, determine the changes that are to be made and those that are not to be made to the system. Several important issues should be considered carefully when establishing a Change Control Board:

- The Change Control Board should be established as soon after the approval of the System Concept as is practical, and no later than the start of the Design stage. The Board reviews requested changes to the

concept, requirements, and design to the system during the evolution of the system, as well as requested changes to an operational system.

- The Change Control Board may act in an advisory capacity to the Project Manager, or may serve as a decision making body. The specific authority of the Board is determined for each system, and is documented in the Configuration Management Plan.

- The Change Control Board is usually chaired by the Project Manager, but may be chaired by any individual.

- The composition of the Change Control Board should reflect those organizations directly affected by the system (e.g., providers of data, direct users of the software, and users of the system outputs).

  -- Systems which affect multiple OSWER offices should include a member of each office on the Board.

  -- Systems which affect the Regional offices and/or state agencies should include at least regional representatives on the Board, and should include State representatives if appropriate.

  -- All Level I systems should include representatives of OIRM and of the OSWER SIRMO. (Refer to practice paper for Reviews and Approvals for definition of a Level I system).

  Specific individuals included on the Board should be determined jointly by the Project Manager and the appropriate program manager(s).

- The Change Control Board may operate under different names, such as 'System Advisory Group', 'Board of Directors', and 'Configuration Management Board'. However, the name Change Control Board is preferred.

- The size and composition of the Change Control Board may change over the life of the system.

- Not all requested changes need be examined by the Change Control Board. The Board may designate certain types of simple, low impact changes that can be approved directly by the Project Manager.

- A project may elect a higher level of review for certain types of requested changes. The Change Control Board may request that these changes be reviewed by the OSWER Information Management Steering Committee.

4. CONFIGURATION MANAGEMENT PLAN

4.1. Purpose of Configuration Management Plan

The Configuration Management Plan describes the organization approach and specific procedures to be used to implement configuration management for the system. It also identifies the physical location of system baselines -- the locations in which hardcopy documentation is stored, and the automated libraries used to store other documentation and the software components of the system.

It should be noted that the Configuration Management Plan provides information that unauthorized individuals might try to use to tamper with the applications software. For security reasons, the identification of automated libraries may be stored external to the Configuration Management Plan, in a document that is less accessible, in order to avoid disclosing such information to unauthorized individuals.

4.2. Development and Update of the Configuration Management Plan

The Configuration Management Plan is a component of the Project Management Plan. It may be included in the Project Management Plan document, or may be developed and maintained as a separate document. The configuration accounting documents should generally be maintained separate from the Project Management Plan, but may be combined for very small, simple systems for which few changes are anticipated.

The Project Manager and Configuration Manager have lead responsibility for development of the Configuration Management Plan.

The Configuration Management Plan is initiated early in the life cycle, and all sections are completed by the end of the Design stage. However, the Configuration Management Plan is continually refined and updated throughout the system life cycle as needed.

Exhibit 4-1 provides an outline of the Configuration Management Plan and illustrates its evolution throughout the life cycle.

4.3. Description of Configuration Management Plan Topics

The Configuration Management Plan should follow the general outline and cover the topics presented in Exhibit 4-2.

EXHIBIT 4-1:
EVOLUTION OF CONFIGURATION MANAGEMENT PLAN THROUGH THE SYSTEM LIFE CYCLE

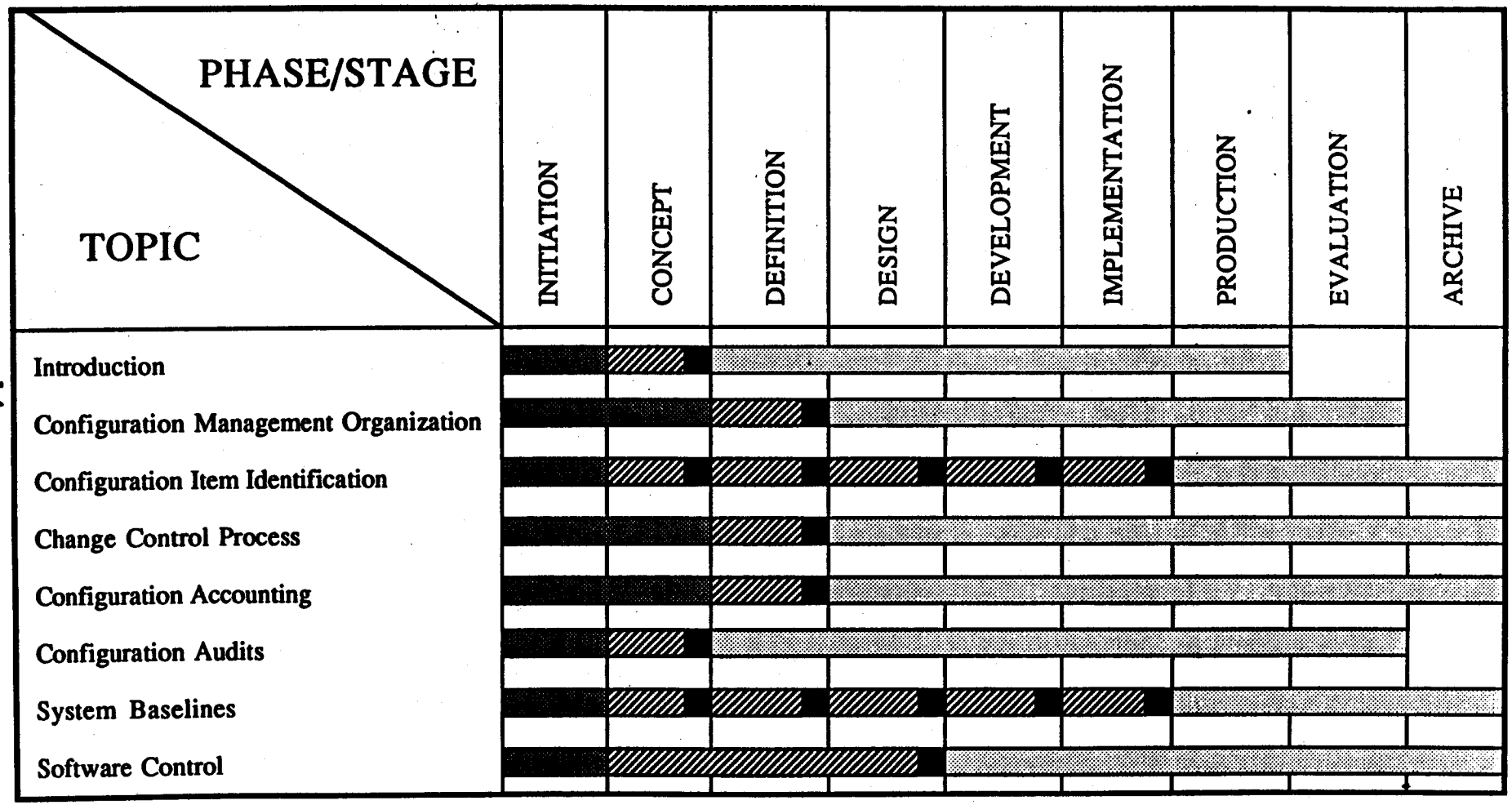


EXHIBIT 4-2
OUTLINE OF CONFIGURATION MANAGEMENT PLAN

- o Introduction
  - -- Identification of the system
  - -- Purpose and scope of the Configuration Management Plan
  - -- Related systems affected by Configuration Management Plan
- o Configuration Management Organization
  - -- Project Manager
  - -- Configuration Manager
    - Individual and home organization
  - -- Change Control Board
    - Role and Authority
    - Chairperson and home organization
    - Other participants and home organizations
    - Staffing and contractor support (if applicable)
- o Configuration Item Identification
  - -- Procedure or method for configuration item identification
  - -- Configuration item indexes for each baseline -- lists of configuration items and cross-references among items (The indexes may be an attachment to Configuration Management Plan)
- o Change Control Process
  - -- Process overview
  - -- Change request procedure and form (if applicable)
  - -- Change request examination criteria
  - -- Levels of examination and approval
  - -- Documentation of examination results and approvals

EXHIBIT 4-2 (continued)
OUTLINE OF CONFIGURATION MANAGEMENT PLAN

- o Configuration Accounting
  - -- Overview of accounting process
  - -- Change request status accounting procedure
  - -- Configuration item status forms and procedure
  - -- Configuration status reporting procedure
  - -- Automated tools used to support status accounting
  - -- Location of status accounting records
- o Configuration Audits
  - -- Audits to be conducted in each phase and stage
  - -- Participants for each audit
  - -- Audit schedule, through implementation
  - -- Frequency of audit in Production stage
  - -- Documentation of audit results and location
- o System Baselines
  - -- Baseline identification
  - -- Products contained in each baseline
  - -- Baseline location(s) (e.g., room locations, computer installations for automated libraries
- o Software Control
  - -- Software control overview
  - -- Software change management procedures and tools
    - Initiation of changes
    - Testing changes
    - Segregation of development and operational environments
    - Approval of changes for release
    - Version control of software changes
    - Procedures for software release

- oo Contents of software release package - software, documentation
- oo Quality control of release packages
- oo Transmission or transmittal of package to each installation
- oo New release installation assistance

- Controls to ensure effective system integration and data base synchronization upon installation of new software

  - oo Synchronization of data base at each installation
  - oo Synchronization of data base across installations for same system
  - oo Synchronization of data base with related data in other systems